



Tennessee Valley Authority, Post Office Box 2000, Decatur, Alabama 35609-2000

March 12, 2018

10 CFR 50.73

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Browns Ferry Nuclear Plant, Unit 3
Renewed Facility Operating License No. DPR-68
NRC Docket No. 50-296

Subject: **Licensee Event Report 50-296/2018-001-00**

The enclosed Licensee Event Report provides details of the Main Turbine Control Valve Pressure Switch mounting bracket breaking away from the mounting bolts causing the Electro-Hydraulic Control line to rupture and a subsequent unit trip. The Tennessee Valley Authority is submitting this report in accordance with Title 10 of the Code of Federal Regulations 50.73(a)(2)(iv)(A), as any event or condition that resulted in manual or automatic actuation of the Reactor Protection System (RPS) including reactor scram or reactor trip.

There are no new regulatory commitments contained in this letter. Should you have any questions concerning this submittal, please contact J. L. Paul, Nuclear Site Licensing Manager, at (256) 729-2636.

Respectfully,

A handwritten signature in blue ink, appearing to read "D. L. Hughes", is written over the word "Respectfully,".

D. L. Hughes
Site Vice President

Enclosure: Licensee Event Report 50-296/2018-001-00 – Separated Pressure Switch Sensing Line Causes Unit 3 SCRAM

cc (w/ Enclosure):

NRC Regional Administrator - Region II NRC Senior Resident Inspector -
Browns Ferry Nuclear Plant


ENCLOSURE

**Browns Ferry Nuclear Plant
Unit 3**

Licensee Event Report 50-296/2018-001-00

Separated Pressure Switch Sensing Line Causes Unit 3 SCRAM

See Enclosed

NRC FORM 366 (04-2017)		U.S. NUCLEAR REGULATORY COMMISSION			APPROVED BY OMB: NO. 3150-0104			EXPIRES: 03/31/2020			
 LICENSEE EVENT REPORT (LER)					Estimated burden per response to comply with this mandatory collection request: 80 hours. Reported lessons learned are incorporated into the licensing process and fed back to industry. Send comments regarding burden estimate to the Information Services Branch (T-2 F43), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by e-mail to Infocollects.Resource@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202, (3150-0104), Office of Management and Budget, Washington, DC 20503. If a means used to impose an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.						
1. FACILITY NAME Browns Ferry Nuclear Plant, Unit 3					2. DOCKET NUMBER 05000296			3. PAGE 1 OF 6			
4. TITLE Separated Pressure Switch Sensing Line Causes Unit 3 SCRAM											
5. EVENT DATE			6. LER NUMBER			7. REPORT DATE			8. OTHER FACILITIES INVOLVED		
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REV NO.	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER	
01	10	2018	2018	001	00	03	12	2018	N/A	N/A	
									FACILITY NAME	DOCKET NUMBER	
									N/A	N/A	
9. OPERATING MODE		11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check all that apply)									
1		<input type="checkbox"/> 20.2201(b)			<input type="checkbox"/> 20.2203(a)(3)(i)			<input type="checkbox"/> 50.73(a)(2)(ii)(A)		<input type="checkbox"/> 50.73(a)(2)(viii)(A)	
		<input type="checkbox"/> 20.2201(d)			<input type="checkbox"/> 20.2203(a)(3)(ii)			<input type="checkbox"/> 50.73(a)(2)(ii)(B)		<input type="checkbox"/> 50.73(a)(2)(viii)(B)	
		<input type="checkbox"/> 20.2203(a)(1)			<input type="checkbox"/> 20.2203(a)(4)			<input type="checkbox"/> 50.73(a)(2)(iii)		<input type="checkbox"/> 50.73(a)(2)(ix)(A)	
		<input type="checkbox"/> 20.2203(a)(2)(i)			<input type="checkbox"/> 50.36(c)(1)(i)(A)			<input checked="" type="checkbox"/> 50.73(a)(2)(iv)(A)		<input type="checkbox"/> 50.73(a)(2)(x)	
074		<input type="checkbox"/> 20.2203(a)(2)(ii)			<input type="checkbox"/> 50.36(c)(1)(ii)(A)			<input type="checkbox"/> 50.73(a)(2)(v)(A)		<input type="checkbox"/> 73.71(a)(4)	
		<input type="checkbox"/> 20.2203(a)(2)(iii)			<input type="checkbox"/> 50.36(c)(2)			<input type="checkbox"/> 50.73(a)(2)(v)(B)		<input type="checkbox"/> 73.71(a)(5)	
		<input type="checkbox"/> 20.2203(a)(2)(iv)			<input type="checkbox"/> 50.46(a)(3)(ii)			<input type="checkbox"/> 50.73(a)(2)(v)(C)		<input type="checkbox"/> 73.77(a)(1)	
		<input type="checkbox"/> 20.2203(a)(2)(v)			<input type="checkbox"/> 50.73(a)(2)(i)(A)			<input type="checkbox"/> 50.73(a)(2)(v)(D)		<input type="checkbox"/> 73.77(a)(2)(i)	
		<input type="checkbox"/> 20.2203(a)(2)(vi)			<input type="checkbox"/> 50.73(a)(2)(i)(B)			<input type="checkbox"/> 50.73(a)(2)(vii)		<input type="checkbox"/> 73.77(a)(2)(ii)	
					<input type="checkbox"/> 50.73(a)(2)(i)(C)			<input type="checkbox"/> OTHER		Specify in Abstract below or in NRC Form 366A	
12. LICENSEE CONTACT FOR THIS LER											
LICENSEE CONTACT Justin K. Garner, Licensing Engineer								TELEPHONE NUMBER (Include Area Code) 256-729-7955			
13. COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT											
CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX		
B	J1	PS	B070	Y	N/A	N/A	N/A	N/A	N/A		
14. SUPPLEMENTAL REPORT EXPECTED					15. EXPECTED SUBMISSION DATE			MONTH	DAY	YEAR	
<input type="checkbox"/> YES (If yes, complete 15. EXPECTED SUBMISSION DATE) <input checked="" type="checkbox"/> NO								N/A	N/A	N/A	
ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines)											
<p>On January 10, 2018, at approximately 0926 Central Standard Time (CST), with Unit 3 at 74 percent power, Browns Ferry Nuclear Plant (BFN) received an automatic scram on Reactor Protection System (RPS) Turbine Control Valve (TCV) fast closure trip. The support bracket for Unit 3 TCV #2 Electro-Hydraulic Control (EHC) pressure switch separated from TCV #2 allowing the mass of the pressure switch to break the hydraulic sense line. As a result, the EHC pressure switch sensed low pressure and triggered a half scram. With a half-scram previously in place due to an unrelated issue from closure of TCV #3, the additional half-scram resulted in an automatic scram on Unit 3 which is a reportable condition. Safety systems responded as designed and the reactor scram was uncomplicated.</p> <p>The apparent cause of this event was determined to be high cycle fatigue failure of the Unit 3 TCV #2 EHC pressure switch support bracket.</p> <p>This failure was corrected by replacing the failed mounting bracket with a newly designed mounting bracket. The corrective action to reduce the probability of recurrence is to install viscoelastic dampeners on the steam piping to reduce the overall piping vibration on the area components. The dampeners are expected to reduce overall piping vibration and the probability of future vibration induced failures of various components in the moisture separator rooms.</p>											

**LICENSEE EVENT REPORT (LER)
CONTINUATION SHEET**

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1. FACILITY NAME	2. DOCKET NUMBER	3. LER NUMBER		
		YEAR	SEQUENTIAL NUMBER	REV NO.
Browns Ferry Nuclear Plant, Unit 3	05000-296	2018	- 001	- 00

NARRATIVE**I. Plant Operating Conditions Before the Event**

At the time of discovery, Browns Ferry Nuclear Plant (BFN), Unit 3 was in Mode 1 at 74 percent power.

II. Description of Event**A. Event Summary**

On January 10, 2018, at approximately 0926 Central Standard Time (CST), with Unit 3 at 74 percent power, BFN received an automatic scram on Reactor Protection System (RPS) Turbine Control Valve (TCV)[PCV] fast closure trip. Unit 3 was operating at reduced power because TCV #3 failed closed due to Linear Variable Differential Transformer (LVDT) failure resulting in a half scram condition on the A2 RPS channel. Subsequently, Unit 3 TCV #2 failed due to the Electro-Hydraulic Control (EHC)[JI] relay emergency trip supply (RETS) pressure dropping because of a high cycle fatigue failure of TCV #2's associated pressure switch (3-PS-047-0144). The pressure switch on the TCV #2 fast acting solenoid valve (FASV)[PSV] disconnected and tripped the B1 RPS channel. A Unit 3 automatic reactor scram was initiated, since the A2 RPS channel was already tripped. All safety systems functioned as expected.

This event was reported by the Tennessee Valley Authority (TVA) in Event Notification (EN) 53162 on January 10, 2018, at 1353 ET, under the four- and eight-hour non-emergency reporting requirements pursuant to Title 10 of the Code of Federal Regulations (10 CFR) 50.72(b)(2)(iv)(B) for an event that resulted in actuation of the RPS when the reactor is critical and 10 CFR 50.72(b)(3)(iv)(A) for a valid actuation of RPS when the actuation results in a reactor scram or trip. This event is also reportable in accordance with 10 CFR 50.73(a)(2)(iv)(A), as an event that resulted in an automatic actuation of the RPS, including reactor scram or reactor trip.

B. Status of structures, components, or systems that were inoperable at the start of the event and that contributed to the event

There were no structures, components, or systems that were inoperable at the start of the event that contributed to the event.



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C. Dates and approximate times of occurrences

Dates & Approximate Times

January 8, 2018, 1124 CST

January 8, 2018, 1151 CST

January 8, 2018, 1152 CST

January 10, 2018, 0926 CST

Occurrence

Operations personnel noted that gain adjustment factors (GAFs) and reactor power were erratic on Integrated Computer System (ICS)[JA]. TCV #3 cycled between 30 percent to 100 percent open. Operations personnel initiated a Recirculation Mid Power Runback in accordance with procedures for the purpose of maintaining Reactor Power at less than 82 percent reactor thermal power. Unit 3 Operations personnel received a half scram on channel A due to manual closure of TCV #3.

BFN Unit 3 received an automatic scram on TCV position

D. Manufacturer and model number of each component that failed during the event

The failed component during this event was the support bracket on the Unit 3 TCV #2 EHC pressure switch. The support bracket is a part of the assembly for the pressure switch. The model number for the pressure switch is 184C4770P001, manufactured by General Electric.

E. Other systems or secondary functions affected

There were no other systems or secondary functions affected by this event.

F. Method of discovery of each component or system failure or procedural error

On January 10, 2018, at approximately 0926 CST, with Unit 3 at 74 percent power, BFN received an automatic scram on RPS TCV fast closure trip. The support bracket for Unit 3 TCV #2 EHC pressure switch was discovered on camera to have broken away from TCV #2.

G. The failure mode, mechanism, and effect of each failed component

The failure mechanism was determined to be high cycle fatigue due to striations found on the fracture surfaces. The boundary between the bracket and the mounting bolt acted as a stress riser. Cyclic stresses applied to the bracket resulted in the formation and propagation of a crack in conjunction with a weak design of the bracket and lack of redundancy to resist initial breakage ultimately led to the failure of the support bracket.

Once the bracket fractured, the pressure switch was supported by the EHC tubing, the electrical conduit, and partially by the rubbing of the broken bracket on the lower broken surface. This post-fracture change in the overall support of the pressure switch transferred a portion of the load to the



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EHC tubing which ultimately failed at the weakest point. The mass of the pressure switch caused the EHC tubing to break resulting in loss of EHC fluid.

H. Operator actions

Upon receiving the automatic scram, Operation personnel responded per Abnormal Operating Instruction, 3-AOI-100-1 (Reactor Scram) and began to control reactor level in accordance with Emergency Operating Instruction, 3-EOI Appendix 5A (Injection Systems Lineup Condensate/Feedwater). Operation personnel controlled reactor pressure control in accordance with, 3-EOI Appendix 8B.

I. Automatically and manually initiated safety system responses

The pressure switch for the TCV #2 FASV disconnected and tripped the B1 RPS. A Unit 3 automatic reactor scram resulted since the A2 RPS channel was already tripped. The automatic reactor scram occurred as designed.

III. Cause of the event

A. Cause of each component or system failure or personnel error

The apparent cause of the TCV #2 EHC pressure switch support bracket failure is high cycle fatigue.

The pressure switch support bracket consists of a band of carbon steel 0.0598 inches thick by 0.745 inches wide bent in a "U" shape. The center fits smoothly around the neck of the pressure switch and the two ends of the bracket extend outward about 1-1/2 inches beyond the pressure switch, allowing for a "stand off distance" each making a 90 degree bend adjacent to the mounting bolt holes used to mount the bracket to the TCV. These 90 degree bends create stress risers and when combined with the light gauge of the material and the mass of the pressure switches resulted in vibration induced fatigue damage.

B. Cause(s) and circumstances for each human performance related root cause

There were no human performance root causes related to this event.

IV. Analysis of the event

TCV Fast Closure inputs to the RPS are from four pressure switches which sense loss of EHC trip fluid pressure. Loss of EHC trip fluid pressure initiates TCV fast closure. One switch is mounted on each of the four TCVs such that fast closure from either normal tripping or from hydraulic line failure is detected. Each pressure switch provides a signal to one of the two channels of RPS. The logic is arranged so that operation of any one switch, or two switches in the same channel, initiates a half scram; and a simultaneous trip in each channel initiates a full reactor scram. Thus, if EHC trip fluid pressure is lost at the TCVs, a TCV Closure reactor trip signal is initiated.

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Operations noted GAFs and reactor power were erratic on the ICS on January 8, 2018. Additionally, TCV #3 was cycling between 30 percent and 100 percent open. TCV #3 was closed, due to the FASV spool being stuck, until entry into the moisture separator room could be made. This resulted in a half scram.

Subsequently TCV #2 failed due to EHC RETS pressure dropping because of a high cycle fatigue failure of TCV #2's associated pressure switch. Tripping the B1 RPS channel with the A2 RPS channel already tripped resulted in a Unit 3 reactor scram.

The cause of this event was determined to be high cycle fatigue failure of the Unit 3 Main TCV #2 EHC pressure switch support bracket. Upon the bracket breaking away, the mass of the pressure switch caused the hydraulic sense line to break resulting in a loss of EHC fluid pressure to the pressure switch.

V. Assessment of Safety Consequences

The automatic reactor trip occurred as designed. Plant equipment performed as designed during the transient. The safety consequences of this event were considered minimal, and there was no impact to radiological safety or the safety of the public.

A. Availability of systems or components that could have performed the same function as the components and systems that failed during the event

At the time of this event TVC #3 had failed closed which resulted in a half scram on January 8, 2018, leaving three available TCVs. The failure of the TCV #2 pressure switch resulted in a second half scram and an automatic reactor scram due to TCV fast closure. The remaining TCVs responded as designed by closing due to the reactor scram.

B. For events that occurred when the reactor was shut down, availability of systems or components needed to shutdown the reactor and maintain safe shutdown conditions, remove residual heat, control the release of radioactive material, or mitigate the consequences of an accident

This event did not occur when the reactor was shutdown.

C. For failure that rendered a train of a safety system inoperable, estimate of the elapsed time from discovery of the failure until the train was returned to service

This event did not result in a train of a subsystem becoming inoperable.

VI. Corrective Actions

Corrective Actions (CAs) are being managed by TVA's corrective action program under Condition Report (CR) 1376060.

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A. Immediate Corrective Actions

The failure was corrected by replacing the mounting bracket with a new mounting bracket and pressure switch.

B. Corrective Actions to Prevent Recurrence or to reduce the probability of similar events occurring in the future

Viscoelastic dampeners are planned to be installed during the upcoming Unit 3 outage to reduce overall piping vibration and are expected to reduce the probability of future vibration induced failures of various components in the moisture separator rooms.

VII. Previous Similar Events at the Same Site

There have been no prior vibration-induced bracket failures that resulted in an automatic scram at BFN.

VIII. Additional Information

There is no additional information.

IX. Commitments

There are no new commitments.